Reading Accuracy vs. Reading Comprehension in Two Children with Autism Spectrum Disorder

A Senior Honors Thesis

Presented in Partial Fulfillment of the Requirements for graduation with research distinction in Speech and Hearing Science in the undergraduate colleges of The Ohio State University

By

Ellen Hambley

The Ohio State University

June 2011

Project Advisor: Dr. Rebecca McCauley, Ph.D., CCC-SLP, Department of Speech and Hearing Science

Table of Contents

Acknowledgements

Special thanks to Dr. Rebecca McCauley, Department of Speech and Hearing Science, and Dr. Paula Rabidoux, of the Ohio State University Nisonger Center; also to Cindy Ring, research associate at Step by Step Academy. In addition, thanks to the participants and their families for being a part of this study. Finally, thanks to the Department of Social and Behavioral Sciences for their funding of this project through the Undergraduate Research Grant.

Abstract

Autism Spectrum Disorder, commonly referred to as ASD, is a developmental condition broadly characterized by impaired communication skills and social interaction, as well as limited interests and repetitive behaviors (NIMH, 2009). Despite an increase in research on the communicative characteristics and effective treatments for this disorder, one area in which there is an especially unfortunate lack of information relates to reading ability of individuals with ASD. This study focuses on identifying specific reading and associated deficits in two children with ASD by examining oral reading rate, accuracy, fluency, and comprehension, as well as oral language function. The methods include assessment of oral reading and oral language skills through administration of reading and language norm-referenced tests as well as examination of literacy development through a parent questionnaire. Results of this study show a unique relationship between reading accuracy and reading comprehension for each participant, as well as variation in patterns of reading errors. Results of this exploratory study provide limited support for the findings of a previous study of reading skills of children with ASD (Nation, Clarke, Wright, & Williams, 2006), but also show variability that requires further study with a greater number of participants.

Introduction

Autism Spectrum Disorder, commonly referred to as ASD, is a complex developmental disability that has gained significant research attention in recent years. Since the disorder was not officially defined until the 1940s, much of the investigation of ASD has occurred recently, within the past few decades (Kanner, 1943). Due to the increased prevalence of ASD and the still limited knowledge of its characteristics and effective methods of treatment (CDC, 2006) it has become a topic of increased importance. This increase in interest has sparked growth in research. For instance, The National Institute of Mental Health's (NIMH) investment in autism-related science has quadrupled from $9.4 million in 1997 to $36.2 million in 2002 (NIMH, 2003).

Since much of the research has occurred within the last few decades, there is still a lack of knowledge in many aspects of the disorder. One of the areas that has not been researched in depth, and applies specifically to the role of speech-language pathologists, is reading skills within the population of individuals with ASD. Speech-language pathologists are vital in the development of literacy for individuals with communication disorders, including those with disabilities, so it is necessary that they are well-informed of the most current discoveries with relation to the disorder (ASHA, 2001, 1). Therefore, research examining the reading characteristics of individuals with ASD is relevant for professionals who work with that population, especially speech-language pathologists.

Literature Review

Children with ASD experience numerous challenges in the literacy learning process, including attention problems and trouble with word decoding (Vacca, 2007). Although such difficulties are common for many of these children, it must be noted that ASD is a spectrum disorder, which can be described as a group of disorders with a range of similar features (NIH, 2010). Therefore, although the characteristics of these individuals are similar, they cover a broad range of severity. Literacy development can involve unique challenges for different individuals on the spectrum. Consequently, although the research that has been conducted on literacy in children with ASD is of merit, depending on the population of individuals that it examined, certain findings may not apply to all individuals across the spectrum.

A few recent studies assess literacy skills of individuals with ASD (e.g., Colasent & Griffith, 1998, Nation, Clarke, Wright, & Williams, 2006). One of the most thorough evaluations was a study (Nation, Clarke, Wright, & Williams, 2006) examining four components of reading skill: word recognition, nonword decoding, text reading, and text comprehension in children with ASD between the ages of 6 and 15 years in the UK. These four components combine to encompass the two major areas of processing that are necessary for successful reading comprehension: word identification and language processing (Nation et al., 2006). Separate investigation of skills within these two main elements of literacy is crucial in order to gain a better understanding of overall literacy ability among children with autism.

Nation and colleagues (2006) limited their selection criteria to factors related to age and communication skills development. All participants were six years of age or older to reflect the fact that literacy instruction among their potential participant pool began at about five years of

age. In addition, all participants were required to have communication skills that were developed enough to allow them to participate in the study. This was based on a general measure obtained by each child's clinician, as all participants were recruited from the Child and Adolescent Mental Health Clinic serving the City of York. It was requested that clinicians refer children that were deemed as having "measureable language skills, however minimal" (Nation et al., 2006, p. 913). Based on the criteria for inclusion within this study, it is evident that this investigation only examined children on the spectrum with those "measureable language skills." Therefore, it cannot be used to make generalizations across the entire spectrum of children with ASD. However, the sample appeared to include a significant range of disorder severity, with 16 of the participants meeting the criteria for autism, 13 for atypical autism, and 12 for Asperger's syndrome. Forty-one children participated in the study, 36 boys and 5 girls, and mean age of the participants was 10.33 years. From this range of individuals, the researchers analyzed reading ability based on tests of both reading accuracy and reading comprehension (Nation et al., 2006).

In total, the researchers performed four assessments of reading for each child; three targeted reading accuracy and one focused on reading comprehension. First, decoding skills were measured with a nonword reading test, *The Graded Nonword Reading Test* (Snowling, Stothard, & McLean, 1996). Children were asked to read aloud items that they had never seen before, which tested their ability to apply letter-sound rules. Second, word recognition was tested using the reading subtest of the *British Ability Scales* (BAS-II; Elliot, Smith, & McCulloch, 1996). For this test, children were asked to read single words aloud and out of context. Third, ability to read connected text was measured with the *Neale Analysis of Reading Ability-II* (NARA-II; Neale, 1997). This test examined each child's ability to read aloud short passages of text. Finally, the *NARA-II* was also used to examine reading comprehension,

because the researchers required the children to answer questions that examined their understanding of the passages they had just read aloud. In addition, measures of oral-language skills were made using the *British Picture Vocabulary Scale-II* (BPVS-II; Dunn, Dunn, Whetton, & Burley, 1997) and the *Wechsler Intelligence Scale for Children* (WISC-III; Wechsler, 1992), while nonverbal ability was examined through the use of the *Block Design* subtest from the *WISC-III* (Nation et al., 2006).

Based on these tests, Nation and her colleagues concluded that 9 of the 41 children were completely unable to read. Therefore, they were excluded from further analysis. For the remaining thirty-two children, the mean standard scores were within normal range for all three assessments of reading accuracy, that is, the tests of nonword reading, word reading, and text reading. On the other hand, the assessments of reading comprehension were, on average, about one standard deviation below population norms and there was extreme variability within the sample in terms of their reading comprehension. Scores on reading comprehension tests varied from floor to ceiling levels, with a total of 65 percent of the participants showing poor reading comprehension, defined as scores at least one standard deviation below population norms.

Nation and colleagues also compared scores of reading accuracy and reading comprehension for each participant. In several cases, the participant demonstrated high levels of reading accuracy, but poor reading comprehension skills. Of the 32 children for whom data were available, 20 scored word-reading levels in or above the normal range. Ten of these children showed reading comprehension in or above the normal range, as well; however, ten of them showed impaired reading comprehension. Therefore, this study suggests that difficulties with reading comprehension are not uncommon among children with ASD. In addition, thirty-five percent of the participants of this study who had the ability to read single words aloud at a

reasonable level showed reading comprehension at least one standard deviation below their text reading accuracy levels. Because of these findings, the researchers identified the need for future research to focus on identifying which specific aspects of the reading comprehension process are impaired (Nation et al., 2006).

Based on the findings of Nation and colleagues, it appears that children with ASD may experience difficulty with reading comprehension. Therefore, it is relevant to explore strategies that have been employed in promoting literacy among this population. Reports exist discussing the evidence-based practices for literacy development among individuals with ASD, along with particular advantages and shortcomings of each method (e.g., Vacca, 2007 and Mirenda, 2003). One particular discussion of such methods, organized by Mirenda (2003), summarizes the current model of literacy instruction that is most frequently used within mainstream education, reasons why it does not apply to children with ASD, and suggestions for a different approach to supporting literacy in these children. Mirenda explains that for many years the "readiness model" has been the predominant foundation for literacy instruction. Under this model, students are required to master the "prerequisite skills deemed essential for literacy development" before educators will proceed with reading instruction. Many students with autism spend the majority of instructional time trying to master phonics, the ability to recognize letter-sound relationships, which is considered to be an essential prerequisite skill for reading. However, traditional phonics instruction is very de-contextualized, which makes it difficult for many children with ASD to demonstrate mastery of the skills in that area (Mirenda, 2003). Therefore, Mirenda reasons that these children may be delayed in the process of literacy development due to the inappropriate application of the so-called "readiness model." She argues that whereas this model may be suitable for use with normally developing children, it tends to place emphasis on

differences for those with ASD and thereby delays their progress (Mirenda, 2003). This approach may also tend to target pre-requisite skills related to decoding rather than skills related to comprehension, which may more often be the areas of challenge for children with ASD (Nation et al., 2006).

Rather than viewing literacy development as an accumulation of subskills, more recent research (Kaderavek & Rabidoux, 2004) has presented it as an interactive process that includes reading, writing, listening, and speaking. This concept is relevant to the literacy learning process for individuals with ASD, such as those involved in the study by Nation and colleagues that demonstrated normal ability in reading accuracy with deficits in reading comprehension (Nation, et al., 2006). In these more recent theories on literacy development, it is clear that reading cannot be defined as simply decoding words and literacy is not one isolated behavior simply defined by the ability to decode or spell words. Text comprehension forces readers to address word meanings and to both retrieve and apply background knowledge and experiences to the text for understanding (Mirenda, 2003). The achievement of literacy development requires all levels of linguistic processing, from the smallest unit of sound to the broad structures of text. Reading and writing are types of language processing, and successful development of these processes depends upon knowledge of spoken language. Words on a page are a visual representation of that language that ultimately must be interpreted by the reader. Reading is not simple recitation of words, but a transformation of print to speech to subsequent meaning (Moats, 2000).

Research examining literacy skills in children with ASD, in conjunction with some of the current theories on literacy development, has provided us with some insight into the reading characteristics of children with ASD compared to their typically developing peers. However, one specific limitation in past research is inadequate examination of the full range of reading

skills. There remains a significant need to identify and describe the identifiable reading characteristics of children with autism spectrum disorder. This knowledge can lead to a better understanding of reading abilities and deficits and assist in the development of evidence based literacy programs. The proposed study will be a case study, a frequently used method in the study of ASD (e.g., Kaderavek & Rabidoux, 2004), examining reading accuracy compared to reading comprehension, as well as assessing the nature of reading errors in two children with ASD.

The case study is preferable to other research methods, such as experiments and surveys, in numerous contexts. Among these are contexts that include attention to "how" or "why" questions, events over which the researcher has limited control, and contemporary trends within a real-life circumstance (Yin, 2009). A case study utilizes many of the same techniques as a history, which is the preferred approach when there is virtually no access or control over the behaviors under examination. However, a case study applies two sources of information generally not available in a history: direct observation and interviews with those individuals involved. Another research approach, the experiment, is utilized when the investigator plans to manipulate behavior in some way. This method focuses on altering one or two variables, with the remaining variables being controlled. The case study differs from the experiment in that it typically does not require control of behavioral events. In these ways, the case study can be differentiated from other forms of research design. The case study has been defined as "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2009, p.18). Therefore, a case study should be used in an attempt to understand a

real-life phenomenon within its context, because that context is particularly significant to the phenomenon of interest.

This case study focuses on reading skills of two children with ASD and involved their parent(s) through completion of questionnaires about the reading characteristics of each child. In addition, reading tests were used to evaluate their reading accuracy and comprehension, as well as their specific reading errors. Finally, language subtests are used examine aspects of their oral language, including language comprehension, which will assist in interpretation of the reading measures. Benefits of this study include an increased understanding of the nature of reading abilities of children with autism spectrum disorder. The specific research goals of this study are:

1. To compare reading accuracy and reading comprehension in two children with ASD.
2. To examine the nature of specific reading errors produced by two children with ASD.

Method

Participants

Two children in elementary school, diagnosed with ASD and described as in the early stages of learning reading comprehension, were recruited from Step by Step Academy in Worthington, Ohio. Two male children, one eight-year old in 3rd grade and one eleven-year old in 5th grade, participated in the study.

Inclusion criteria. Inclusion in the study was dependent upon completion of a social communication screening, The Social Communication Questionnaire (SCQ; Rutter, Bailey & Lord, 2003). We did not have access to medical or educational records indicating a diagnosis of

ASD for these participants; therefore, this questionnaire was administered to the parents/guardians of participants in order to verify the general diagnosis of ASD.

Materials

Inclusion tasks. Social communication screening: Social Communication Questionnaire (SCQ). Parents were asked to answer questions about their child's social skills in a questionnaire format. The SCQ is a brief instrument that helps evaluate communication skills and social functioning in children who may have autism spectrum disorder (Allen, Silove, Williams, and Hutchins, 2006). It can be reported by a parent or primary caregiver in less than 10 minutes and is designed for use with individuals of the age 4 years, 0 months or older whose mental age exceeds 2 years. The SCQ is available in two forms, Lifetime and Current, each of which consist of 40 yes-or-no questions. Both forms are given directly to the parent, who can answer the questions without supervision. The Current Form focuses on the child's behavior over the most recent 3-month period. The Lifetime Form concentrates on the child's entire developmental history, providing a Total Score that is interpreted in relation to specific cutoff points. This form was used to verify the child's general diagnosis for the purposes of this study and to provide additional descriptive information.

Assessment tasks. Oral reading skills: The Gray Oral Reading Test (GORT 4; Wiederholt & Bryant, 2001) was administered to the participants to assess their reading skills. The GORT-4 provides an objective measure of oral reading rate, accuracy, fluency, and comprehension. It serves as an evaluation of effects of instruction over time on oral reading and aids in the diagnosis of oral reading difficulties. Designed for children from age 7 years, 0 months to 18 years, 11 months, the test consists of two parallel forms, A and B, that contain 14

separate stories with five multiple choice comprehension questions for each story. The GORT-4 has an error analysis system for evaluating types of errors or miscues made in five areas: meaning similarity, function similarity, graphic/phonemic similarity, multiple sources, and self-correction. The frequency of each error is reported as a percentage and this information can be used to identify specific reading difficulties.

Oral language skills: Subtests of the Clinical Evaluation of Language Fundamentals-4 (CELF-4; Semel, Wiig, & Secord, 2003) were administered to the participants to examine aspects of their oral language, including language comprehension. This test is designed for children from age 5 years, 0 months to 21 years. Depending on the age of the participant, the CELF-4 includes 3 or 4 subtests in order to calculate a Core Language score. This score provides an overall measure of oral language function. In addition, one subtest of those used to calculate the Core Language Score assesses receptive language, the Concepts and Following Directions subtest. Use of these measures provided additional information to aid in the interpretation of the reading measures.

Observation of reading skills: Parent Questionnaire and Observational Rating Scale of the CELF-4. Parents were asked to rate their child's reading accuracy and reading comprehension on a scale from 1 to 10 and explain the reasoning behind their ratings. Parents were also asked to complete a survey with questions corresponding to the skills examined in the CELF-4. One section of this survey asked parents to rate their child's particular reading behaviors on a range of frequencies, including never, sometimes, often, and always.

Procedures

All participants were administered the Gray Oral Reading Tests (GORT 4; Wiederholt & Bryant, 2001), a reading skills analysis consisting of an oral reading test, followed by a comprehension question test. All participants were administered a core language test consisting of 3, or 4, subtests (depending on age) of the CELF (CELF-4; Semel, Wiig, & Secord, 2003). Each child was tested individually by the researcher in a quiet room. All testing was completed in one session per participant, lasting one and a half hours each. All of the sessions were audio recorded for data analysis.

Results and Discussion

Social Communication Screening

Results of the SCQ confirmed that both children fell under the ASD classification based on a score of ≥15. Participant 1 received a score of 28 and Participant 2 received a score of 25. Based on the results of this questionnaire, both children were considered appropriate study participants and parents of both children gave consent for their child's participation.

Reading Accuracy and Comprehension

Results of the GORT-4 provided information on each participant's oral reading rate, accuracy, fluency, and comprehension. Each child's oral reading was timed in order to determine a rate score, their errors were tallied to achieve an accuracy score, the rate and accuracy score combined to create the fluency score, and each participant was asked a series of comprehension questions after each reading passage to designate a comprehension score. Results of testing are displayed in Figure 1. Participant 1 demonstrated rate, fluency, and comprehension scores that fell into the above average range, with accuracy scores in the average range. He did not display the relationship between accuracy and comprehension that

was expected based on some of the participants of the previous study by Nation and colleagues, as his reading accuracy score was poorer than his reading comprehension score. Participant 2 exhibited below average scores in all four skill areas. Specifically, his rate, accuracy, and fluency scores were categorized as below average, with his comprehension scores falling into the very poor range. Based on his scores, he did exhibit the previously observed relationship between accuracy and comprehension, as his reading accuracy scores were stronger than his reading comprehension scores. See Figure 1 for each participant's rate, accuracy, fluency, and comprehension scores.

Oral Reading Errors

Results of the GORT-4 were also used to assess the nature of each participant's reading errors. A miscue analysis was performed on the deviations from print that occurred in each participant's oral reading testing. Each error was categorized based on the way in which it was similar to the correct printed word. Errors were grouped into the following categories: meaning similarity, function similarity, graphic/phonemic similarity, multiple sources, and self-correction. Errors demonstrated meaning similarity if the error word was similar in meaning to the print word. Errors showed function similarity if the error word was similar in grammatical function to the print word. Errors fell into the category of graphic/phonemic similarity if the error word was similar in spelling or pronunciation to the print word. If the error was placed into more than one of the previously mentioned categories, it was also categorized as an error of multiple sources. Finally, if the reader corrected his own error, that error was also classified as a self-correction. See Table 1 for examples of each type of error.

Each participant's errors were categorized and examined for trends based on their percentage of errors in each category. Participant 1 exhibited the highest percentage of errors with both function similarity and graphic/phonemic similarity. In each case, both function similarity and graphic/phonemic similarity, 7 of 10 of his errors fell into that category. He showed the lowest percentage of errors with meaning similarity; however, that percentage was 50%, or 5 of 10 errors. This means that 50% of his errors did significantly change the meaning of the printed word. It should also be noted that Participant 1 made no self-corrections of his errors. Participant 2 showed the highest percentage of errors with graphic/phonemic similarity, with 8 of 12, or 75%, of his errors being categorized by graphic/phonemic similarity. He showed the lowest percentage of errors with meaning similarity, with 4 of 12, or 33%, of his errors falling into that category. He also made self-corrections of 50%, or 5 of 10, of his errors. See Figure 2 for details on the categorization of errors for each participant.

Examining the error patterns of both participants provides information on ways in which each participant's errors changed the text. It is clear from the results that the majority of errors made by both did not significantly change the spelling or pronunciation of the printed word. In addition, most of the errors produced by Participant 1 did not change the grammatical function of the printed word, as 7 of his 10 errors, or 70% were categorized as having function similarity. For Participant 2, half of his errors, or 6 of 12, did change the grammatical function of the word. Therefore, for Participant 1, most of his errors did not result in a significant change in spelling, pronunciation, or grammatical function of the text. While 8 of 12, or 67%, of the errors made by Participant 2 did not drastically change the spelling or pronunciation of the text, half, or 6 of 12, of them did change the grammatical function.

Five of 10, or 50%, of the errors made by Participant 1 did not change the meaning of the printed word, while only 4 of 12, or one-third, of the errors produced by Participant 2 did not change the meaning. This means that for Participant 2, the majority of his errors actually changed the meaning of the word that he was attempting to read. Eight of 12 of his errors resulted in a change in meaning of the printed word. For Participant 1, this was the case for 5 of 10, or half, of his errors. The resulting change in meaning to the printed text may have had an impact on the participants' comprehension.

Oral Language

Results of the subtests of the CELF-4 gave an illustration of each participant's oral language function. This additional oral language testing was completed in order to gain further information on the participants' oral language ability. Poor oral language skills would certainly affect oral reading ability; therefore, this additional information was beneficial in interpreting the reading skills of each participant. Participant 1 completed the following subtests relevant to oral language: concepts and following directions, word structure, recalling sentences, and formulating sentences. Participant 2 completed the same subtests with the exception of the word structure subtest, as it was not included in the required oral language sequence for his age range. Participant 1 demonstrated scores in the average range for all subtests except the concepts and following directions subtest. His below average score on this particular subtest reflects his poor ability to wait for a prompt to begin the requested direction, rather than an inability to comprehend the spoken direction. Participant 2 demonstrated scores in the below average range on all subtests. In contrast to Participant 1, his low score on the concepts and following directions subtest reflected his poor ability to complete the directions accurately. It is important to note that the oral language ability of each participant corresponds to his oral

reading ability. In general, Participant 1 showed average oral language ability and average or above average oral reading ability. Conversely, Participant 2 showed below average oral language ability, as well as below average oral reading ability. See Figure 3 for each participant's scores on the oral language subtests of the CELF-4.

Reading Skills Questionnaire

Results of this parent questionnaire gave us information on each parent's personal evaluation of their child's reading skills. Parents were asked to rate their child's reading accuracy and reading comprehension on a scale of 1 to 10, with the lower scores representing poor ability and the higher scores representing strong ability. Participant 1 received a rating of 5 for reading accuracy and a 7 for reading comprehension. Participant 2 received a rating of 5 for reading accuracy and a 3 for reading comprehension. These scores did correspond with the relationships found in the results of the reading testing, as Participant 1 showed accuracy scores poorer than comprehension scores and Participant 2 showed accuracy scores higher than comprehension scores.

CELF-4 Observational Rating Scale

Parents also completed an Observational Rating Scale that went along with the CELF-4. One section of this survey asked parents to rate their child's particular reading behaviors on a range of frequencies, including never, sometimes, often, and always. See Figure 4 for the ratings reported by each participant's parent. Participant 2 was described as often having trouble with comprehension aspects of reading, including "understanding what was read," "explaining what was read," and "identifying the main idea." This corresponds with his poor comprehension score on the GORT-4. Participant 1 had steady ratings of sometimes having

trouble with all areas, with the exception of "sounding out words when reading." His parent reported that he never has trouble sounding out words. This corresponds with the fact that the majority of his reading errors on the GORT-4 fell into the graphic/phonemic similarity category, meaning that they did not significantly change the pronunciation or spelling of the printed word. A recent study on the Observational Rating Scale of the CELF-4 (Massa, Gomes, Tartter, Wolfson, & Halperin, 2008) examined the degree to which parent and teacher ratings of children were in agreement, as well as the relationship between ORS ratings and scores on standardized language and reading tests. Results showed that agreement of parent and teacher ratings was significant and that there were significant relationships between ORS ratings and performance on language and reading tests. This significant connection between parent and teacher ratings is of consequence in the present study, as we were only able to attain ratings from the parents of participants, and not from teachers. In addition, the results of the present study show correlation between each child's ORS rating and his performance on reading tests, as the study by Massa and colleagues found significant relationships between such scores.

Discussion

As a pilot study with two participants, the data collected in this study cannot be used to draw any broad conclusions about the reading skills of children with ASD. However, we can use the information on the reading skills of these two participants to note general trends in reading abilities and deficits for each participant. Based on those trends, we may be able to recommend specific skills to target in literacy learning for each individual child.

A common trend did not exist between participants in the relationship between reading accuracy and reading comprehension skills. Participant 2 displayed the expected relationship based on previous research (Nation et al., 2006), as his reading accuracy was stronger than his comprehension. However, Participant 1 displayed the opposite relationship: his reading accuracy was poorer than his reading comprehension. In addition, each participant exhibited different levels of strength in reading skills. Participant 1 scored in the average to above average range in all aspects tested: rate, accuracy, fluency, and comprehension. Conversely, Participant 2 scored below average in all four areas. It is important to note this disparity in scores, especially based on the age and grade level of each participant. Participant 1 had strong overall reading skills in all component areas assessed, as an 8-year-old in 3rd grade. In contrast, Participant 2 had below average reading skills in all areas tested, as an 11-year-old in 5th grade. One limitation of this study is the lack of access to medical and educational records for additional information on specific details of each child's diagnosis of ASD. Access to such records could be valuable, as they may contain information that would give a more detailed context of the child as a whole.

Despite the differences in accuracy and comprehension skills, there were some similarities observed in the pattern of both participants' reading errors. For both children, the majority of their errors did not significantly change the spelling or pronunciation of the printed word. This means that, in most cases, these children were preserving the spelling or sound of the word. In addition, for both children, the smallest percentage of their errors out of all of the possible categories fell under meaning similarity. This means that many of their errors, 50% for Participant 1 and 67% for Participant 2, did alter the meaning of the word that they were attempting to read in the passage. This type of error could easily affect the reader's ability to

answer comprehension questions correctly, as a change in meaning to one word could have a significant impact on the interpretation of that section of the passage.

The error patterns of the participants in this study suggest that these children are focusing more on accurately decoding text, and less on preserving the meaning of the passage. Since most of their errors do not change the spelling or pronunciation of the words, while many of their errors change the meaning, it may be that these children are concentrating on deciphering each word, and have more difficulty focusing on the comprehension aspect of reading. This seems to correspond to the early stages of the "readiness model" (Mirenda, 2003) of literacy learning, in that these children may be primarily focusing on phonics to correctly decode the text. These children may benefit from reading instruction focusing on meaning, expanding upon their ability to decode words.

With that being said, when turning away from the nature of the reading errors and examining the reading accuracy and comprehension scores, it is important to note that Participant 1 did score in the above average range on the comprehension measures. It appears that in addition to having strong decoding skills, he exhibits strong comprehension skills. Looking at the previous discussion of error patterns and their effect on comprehension, based on the fact that half of his errors changed the meaning of the print word, we would expect that to have at least some effect on comprehension. Even though half of his errors significantly changed the meaning of the print word, he was still able to answer comprehension questions at a level that was designated as above average for his age range. At this point, it is essential to remember that all of his reading skills fell into the average or above average range. In addition, his general oral language scores were in the average range for 3 of 4 subtests. Therefore, his performance on the comprehension assessment does correspond with his consistently strong

oral reading and oral language skills. Even though he made errors that affected meaning, he was able to grasp the larger overall meaning of the passage. Also, when supposing that the errors that resulted in a change in meaning may have affected comprehension for Participant 2, we should recall that all of the oral reading scores and oral language scores of Participant 2 fell into the below average range for his age group. Therefore, his low comprehension scores are consistent with his below average oral reading and oral language function.

Summary and Conclusions

This study provides limited support for the previous study (Nation et al, 2006) examining reading skills of children with ASD. Participant 1 did not exhibit the hypothesized relationship between reading comprehension and reading accuracy. Rather, his reading comprehension was stronger than his accuracy. However, Participant 2 did exhibit the hypothesized relationship between comprehension and accuracy: his accuracy was stronger than his comprehension. This hypothesis was based on the previous study (Nation et al, 2006) showing accuracy scores within normal ranges and comprehension scores, on average, one standard deviation below norms in children with ASD.

When assessing the nature of participants' errors, both exhibited most errors with function similarity, meaning that the error word was similar in grammatical function to the printed word, or graphic/phonemic similarity, meaning that the error word was similar graphically and phonemically to the printed word. Both participants exhibited least errors with meaning similarity, meaning that the error word was similar in meaning to the printed word. Whereas both participants showed a similar trend in that the fewest number of their errors exhibited meaning similarity, there was variability in other types of errors.

These results appear to provide limited support for the findings by Nation et al., but also show variability that requires further study beyond an exploratory study, such as that described here, with a greater number of participants. As a pilot study, this research was designed as a first step to precede a larger, more rigorous study. Further studies should involve a larger participant pool, examination of medical and education records, if possible, and retesting of participants to examine consistency of scores.

References

Allen, C.W., Silove, N., Williams, K., and Hutchins, P. (2006). Validity of the Social Communication Questionnaire in Assessing Risk of Autism in Preschool Children with Developmental Problems. *Journal of Autism and Developmental Disorders, 37 (7),* 1272-1278. Retrieved from http://web.ebscohost.com.proxy.lib.ohio-state.edu/ehost.

American Speech-Language Hearing Association. (2001). Roles and Responsibilities of Speech-Language Pathologists With Respect to Reading and Writing in Children and Adolescents. Retrieved from http://www.asha.org.

American Speech-Language Hearing Association. (2006). Principles for Speech-Language Pathologists in Diagnosis, Assessment, and Treatment of Autism Spectrum Disorders Across the Life Span. Retrieved from http://www.asha.org.

Center for Disease Control and Prevention. (2006). How Many Children Have Autism? Retrieved from http://www.cdc.gov/ncbddd/features/counting-autism.html.

Colasent, R., & Griffith, P. L. (1998). Autism and literacy: Looking into the classroom with rabbit stories. *The Reading Teacher, 51(5),* 414-420. Retrieved from http://web.ebscohost.com.proxy.lib.ohio-state.edu/ehost.

Dunn, L.M., Dunn, L.M., Whetton, C., & Burley, J. (1997). *British Picture Vocabulary Scale-II*. England: GL Assessment.

Kaderavek, J. & Rabidoux, P. (2004). Interactive to independent literacy: A model for designing literacy goals for children with atypical communication. *Reading and Writing Quarterly, 20,* 237-260. Retrieved from http://web.ebscohost.com.proxy.lib.ohio-state.edu/ehost.

Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child, 2,* 217-50.

Mirenda, P. (2003). "He's not really a reader...": Perspectives on supporting literacy development in individuals with autism. *Top Lang Disorders, 23(4),* 271-282. Retrieved from http://web.ebscohost.com.proxy.lib.ohio-state.edu/ehost.

Moats, L. (2000). *Speech to Print: Language Essentials for Teachers.* Maryland: Paul H. Brooks Publishing Co.

Nation, K., Clarke, P., Wright, B.J., & Williams, C. (2006). Patterns of reading ability in children with autism spectrum disorder. *Juvenile Autism Developmental Disorders, 36,* 911-919. Retrieved from http://web.ebscohost.com.proxy.lib.ohio-state.edu/ehost.

National Institute of Mental Health. (2003). Autism Spectrum Disorders Research at the National Institute of Mental Health. Retrieved from http://counsellingresource.com/distress/autistic/autism-research-1.html.

National Institute of Mental Health. (2009). What Are the Autism Spectrum Disorders? Retrieved from http://www.nimh.nih.gov/health/publications/autism/what-are-the-autism-spectrum-disorders.shtml.

National Institutes of Health Eunice Kennedy Shriver National Institute of Child Health & Human Development. (2010). Autism Spectrum Disorders (ASDs). Retrieved from http://www.nichd.nih.gov/health/topics/asd.cfm.

Neale, M.D. (1997). *Neale Analysis of Reading Ability-II*. Australia: ACER Press.

Snowling, M.J., Stothard, S.E., & McLean, J.M. (1996). *The Graded Nonword Reading Test.* Bury St. Edmonds: Thames Valley Test.

Vacca, James S. (2007). Autistic Children Can Be Taught To Read. *International Journal of Special Education, 22,* 54-61. Retrieved from http://web.ebscohost.com.proxy.lib.ohio-state.edu/ehost.

Wechsler, D. (1992). *Wechsler Intelligence Scale for Children.* New York: Psychological Corporation.

Yin, Robert K. (2009). *Case study research: Design and methods.* California: SAGE Publications, Inc.

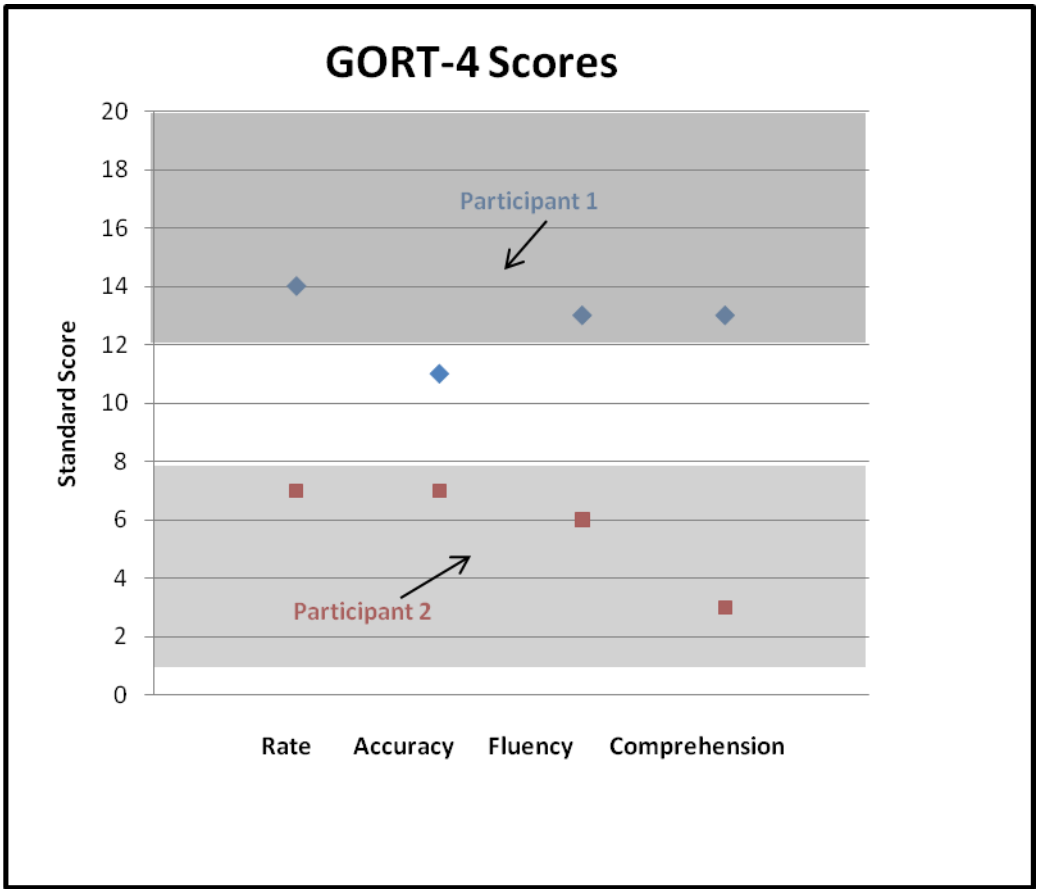

Figure 1. GORT-4 Scores. This figure illustrates the oral reading rate, accuracy, fluency, and comprehension scores of each participant.

Table 1		
Examples of Types of Miscues		
Meaning Similarity		
Text Word	Miscue	Meaning Similarity
hoped	wished	1
a	the	1
Function Similarity		
Text Word	Miscue	Function Similarity
hoped	wished	1
a	the	1
Graphic/Phonemic Similarity		
Text Word	Miscue	Graphic/Phonemic Similarity
washed	wished	1
moment	minute	1
Multiple Sources		
Text Word	Miscue	Multiple Sources
hoped	wished	1
a	the	1

Note: These examples do not reflect data from participants of the present study.

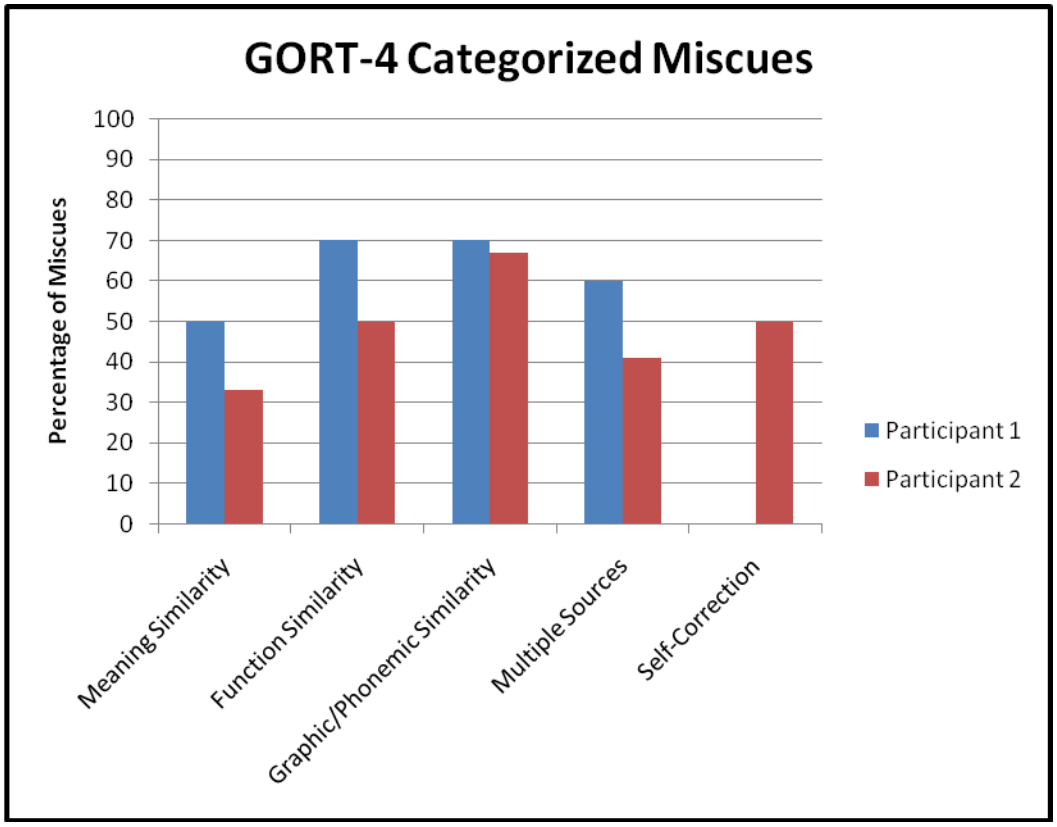

Figure 2. GORT-4 Categorized Miscues. This figure illustrates percentages of each participant's errors that were categorized into the following groups: meaning similarity, function similarity, graphic/phonemic similarity, multiple sources, and self correction.

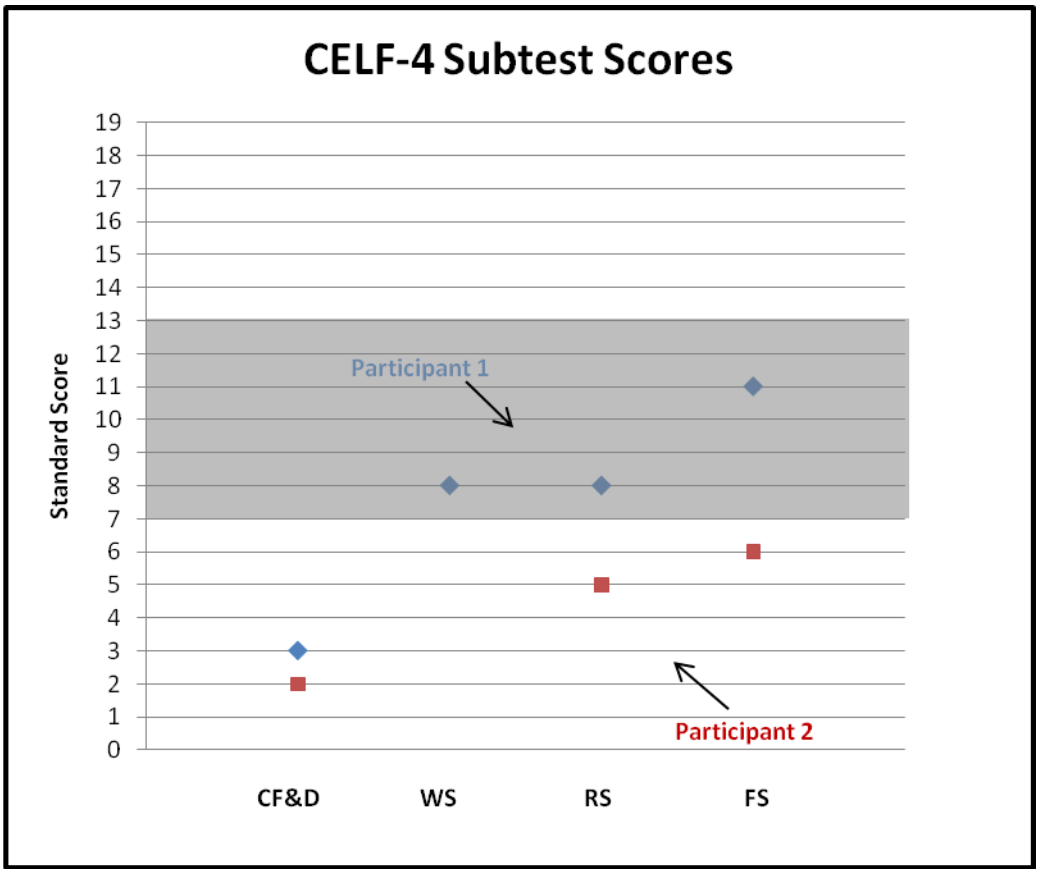

Figure 3. CELF-4 Subtest Scores. This figure illustrates each participant's score on the following oral language subtests: concepts and following directions, word structure, recalling sentences, and formulated sentences. *Note*: Participant 2 was not required to complete the word structure subtest, as it was not included in the oral language sequence for his age group.

Figure 4

Reading Skills Reported by Parents on Observational Rating Scale of the CELF-4

	Participant 1				Participant 2			
	Never	Sometimes	Often	Always	Never	Sometimes	Often	Always
Has trouble sounding out words when reading	X					X		
Has trouble understanding what was read		X					X	
Has trouble explaining what was read		X					X	
Has trouble identifying the main idea		X					X	
Has trouble remembering details		X				X		
Has trouble following written directions		X				X		

Figure 4. Reading Skills Reported by Parents on Observational Rating Scale of the CELF-4. This figure illustrates the ratings of reading skills given by the parent of each participant.